SLUO 2008

Annual SLAC Users Organization Meeting

September 18, 2008

http://www-group.slac.stanford.edu/sluo/

SLUO Annual Meeting
September 18, 2008

Time	Title	Speaker	Download
08:00 - 08:30	Continental Breakfast		
08:30 - 08:45	Introductory Remarks with Messages to SLUO from Congresswoman Anna Eshoo and Congressman Mike Honda (15 mins)		
	- Gérard Bonneaud - Ecole Polytechnique CNRS/IN2P3 (15 mins)	Gérard Bonneaud	
08:45 - 10:05	**The Lab**	Gérard Bonneaud (Chair)	
	- Vision for SLAC Science (40 mins)	Persis Drell	
	- The PPA Paradigm (40 mins)	Steve Kahn	
10:05 – 10:30	Coffee Break		
10:30 – 12:30	**Future of Physical Sciences: Views from Washington**	Grzegorz Madejski (Chair)	
	- by Mike Holland (Program Examiner, Office of Management and Budget - Energy Branch) (40 mins)	Mike Holland	
	- by Joseph Dehmer (Director, National Science Foundation - Division of Physics) (40 mins)	Joseph Dehmer	
	- by Dennis Kovar (Associate Director, Department of Energy - Office of High Energy Physics) (40 mins)	Dennis Kovar	

SLUO Annual Meeting September 18, 2008

Time	Title	Speaker	Download
14:00 – 18:30	**Present & Future of SLAC Science**		
14:00 – 16:00	**Discussion Panel on "Accelerator-based Physics -- The Discovery Frontiers"** ***Panel Members:*** *Barry Barish,* ***Jonathan Dorfan (Moderator),*** *Gil Gilchriese, Patric Muggli, Michael Peskin, Blair Ratcliff, Tor Raubenheimer, Harry Weerts*		
	• **Introduction** (5 mins)	Jonathan Dorfan - SLAC	
	• **Energy and Flavor Frontiers**		
	- Physics Opportunities (20 mins)	Michael Peskin - SLAC	
	- Accelerator R&D Opportunities (20 mins)	Tor Raubenheimer - SLAC	
	- Atlas Detector Upgrade Opportunities (10 mins)	Gil Gilchriese - LBNL	
	- SiD – A Compact ILC Detector (10 mins)	Harry Weerts - ANL	
	- Super-B Detector Opportunities (10 mins)	Blair Ratcliff - SLAC	
	• **Accelerator Frontier**		
	- FACET - Going Beyond Current Techniques (15 mins)	Patric Muggli - USC	
	• **Discussion** (30 mins)		
16:00 – 16:15	Coffee Break		
16:15 – 18:30	**Discussion Panel on "The Cosmic Frontier"** ***Panel Members:*** *all Speakers with* ***Roger Blandford (Moderator)***		

Scientific Vision for SLAC

* Strong Photon Science program
  – World leading on site facilities
* Strong Particle Physics and Astrophysics
  – Focus on energy frontier and cosmological frontier
* Accelerator science
  – Core competency of the laboratory
  – Key tools for discovery in many scientific areas

Particle Physics Today

* The most exciting time scientifically in my career lifetime
  - Opening of TeV frontier
  - Mystery of neutrino masses and mixing
  - Dark Energy
  - Dark Matter
* Healthy particle physics program very important to US going forward
  - Priority for SLAC

New Paradigm for the US

* The frontier of accelerator based particle physics is off shore for the next decade
* Particle physics will thrive in the next decade
  – Will the US continue to play a leadership role?
* How can national laboratories help support the user community to be effective participants
  – At accelerators abroad?
  – In non accelerator based experiments?

SLAC Support for Users Going Forward

* Highest priority for the field is energy frontier
  – SLAC will support users at LHC
* Exploration of the ‘Dark Universe’
  – New models of user support by national labs
    • GLAST now
    • LSST, JDEM future

Electron Accelerator Science at SLAC

* Core competency of the laboratory
  – Essential to future science strategy of the lab and the field
* Our future science strategy depends on advances in electron accelerators
* Both Photon Science and Particle Physics rely on advances in electron accelerator science

Summary

* SLAC is transforming to optimize for its future
* Particle physics program high priority for lab going forward
  - Strong user support role essential to health and viability of particle physics at SLAC
  - Still working to optimize our role for the user community in this new era

Steve Kahn

Mike Holland, OMB Examiner

- No slides
  - Quarks to Cosmos and Quantum Universe
  - What would US lose if it did not do HEP?
  - 2,4,6,8 years matter, not 20
  - NLC R&D contribution to SNS good
  - HEP benefited from historical role of leaders as advisors in DC
  - Politician do want to support “discovery science”
  - Be careful with your message
  - Training of people matter - may need professional help in describing this
  - EPP2010

- The aforementioned questions are addressed at DUSEL via a variety of experimental probes:
  - Direct Detection of Dark Matter
  - Neutrino-less Double-Beta Decay
  - Nuclear Astrophysics
    - Accelerator-based cross-section measurements
  - Solar Neutrinos
  - Long Baseline Experiment, Proton Decay, and Supernovae Remnants (Mega-Detector)

DUSEL MREFC funding would support the construction of forefront experiments in nuclear- and astro-physics, and in particle physics using the Fermilab accelerator as a high intensity neutrino source.

Discussions on DUSEL with DOE

DEHMER

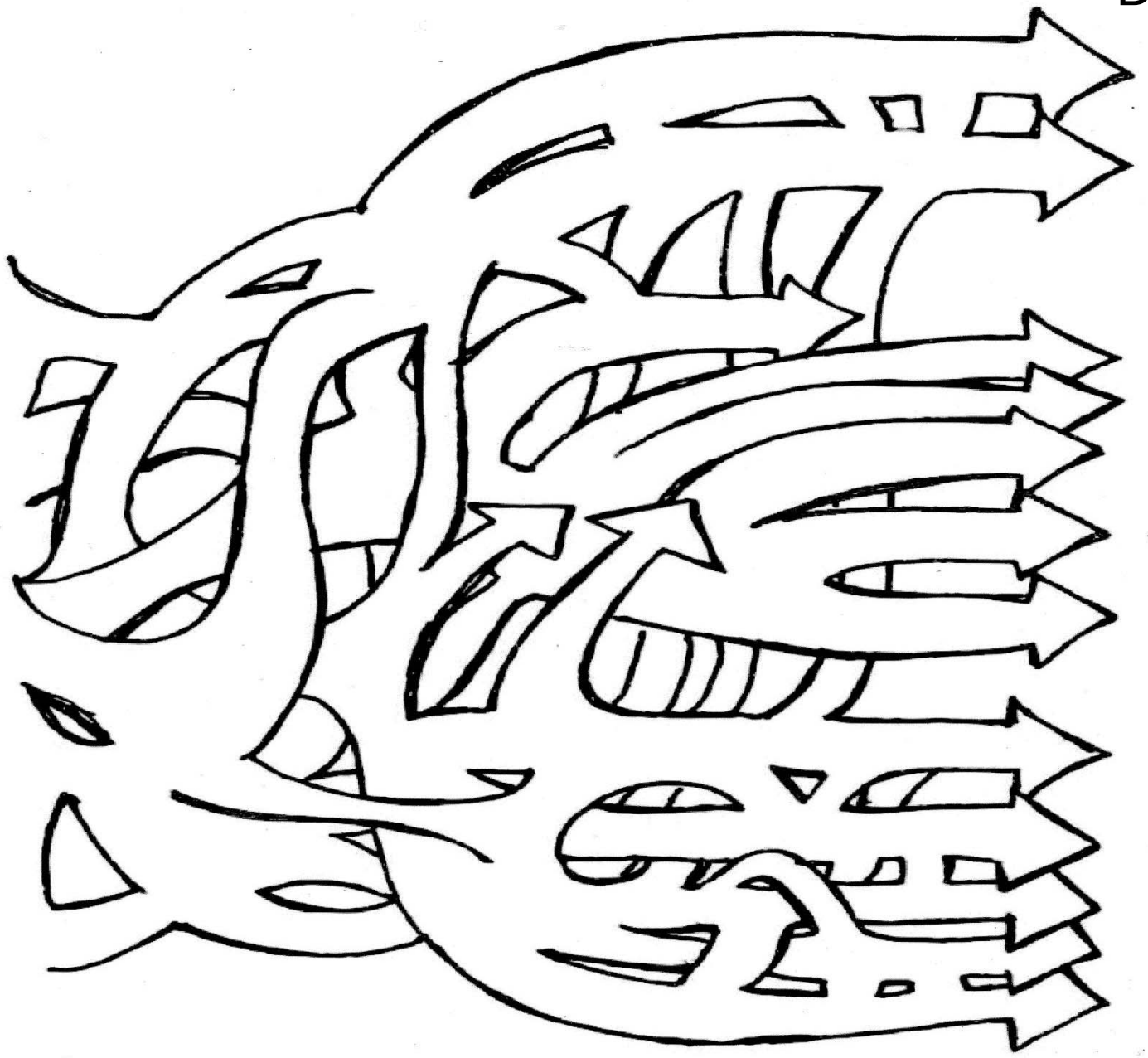
- NSF/DOE DUSEL Physics Joint Oversight Group (JOG)
  being developed.
- JOG would oversee those physics experiments jointly implemented by NSF and DOE at DUSEL.
- Roles & responsibilities being based on past models.
  - Among them, successful DOE/NSF JOG oversight of US participation in the Large Hadron Collider (LHC) at CER
- Three meetings in June/July 2008.
  - Attending: NSF MPS & PHY, DOE OHEP & ONP.
- Draft MoU describing NSF/DOE cooperation has bee agreed to and submitted for approval.

DUSEL Working Timeline

- 16-18 July 08: Internal project review of facility.
- December 08: NSF Project Review of DUSEL.
- December 09: NSF Preliminary Design Review of DUSEL.
  - Project readiness, plan will be assessed at this milestone.
- Spring 10: Presentation of DUSEL package to NSB.
- FY12: Earliest construction funding (MREFC) start, if approved.

Planning with potential partners (DOE, international, etc.) will be integrated into above schedule.

DEHMER



office of high energy physics

Status of U.S. HEP

Department of Energy
Office of Science

- **HEP is at a productive and exciting period today**
  - **Significant discoveries anticipated over the next decade**
    - **at the energy frontier**
    - **at the intensity frontier**
    - **at the particle astrophysics frontier**

- **But current circumstances for the U.S. program are challenging**
  - **Competition for federal funding is fierce**
    - **HEP is not a priority of the Administration or Congress**
    - **HEP funding has eroded over the last decade**
    - **"Why does the U.S. have to be a leader in HEP (particle physics)?"**
    - **"What is particle physics"?**
  - **Reductions in FY 2008 funding resulted in loss of**
    - **HEP's scientific productivity and workforce**
    - **Momentum on planned activities (NOvA, SRF infrastructure, ILC R&D)**
    - **U.S. credibility as an interagency/international collaborator (BaBar, ILC)**
  - **A realistic strategic plan for a world-class program that deals with**
    - **the increase in cost and the delay in possible start of an ILC**
    - **energy frontier moving to Europe in FY 2009 & closure of Tevatron**
    - **Fermilab's role in the future**

    has been (is being) developed that needs to accepted and implemented!

KOVAR

Need for a Realistic Strategic Plan

Guidance Sought from the Community

DOE/NSF Charge to HEPAP (P5) (November 2007/revised January 2008)

Identify and evaluate the scientific opportunities and options that can be pursued **at different funding levels for** mounting **a world-class,** vigorous and productive **national particle physics science program**.

Understand and evaluate the role Fermilab will play in the national and worldwide context of particle physics over the next two decades.

Recommendations on the priorities for an optimized high energy physics program over the next ten years (FY 2009-2018), under the following four funding profile scenarios:

- Constant effort at the FY 2008 (Omnibus) funding level
- Constant effort at the FY 2007 funding level
- Doubling of funding starting in FY 2007
- Additional funding above the previous level, in priority order, associated with specific activities needed to mount a leadership program that addresses the scientific opportunities identified in the National Academy ("EPP2010") report.

Report was submitted in June 2008

KOVAR

HEPAP (P5) Report

Major Findings

- **Progress in achieving the goals of particle physics requires advancements at the:**
  - **Energy Frontier**
  - **Intensity (or precision) Frontier**
  - **Cosmic (or particle astrophysics) Frontier**

  (each provides a unique window for insight about the fundamental forces/particles of nature)

- **LHC offers an outstanding opportunity for discoveries at the Energy Frontier**
  - Resources will be needed to support the extraction of the science by U.S. scientists
  - Resources will be needed for planned accelerator and detector upgrades

- **An opportunity exists for the U.S. to become a world leader at the Intensity Frontier**
  - Central is an intense neutrino beam and large underground long-based line detector
  - Building on infrastructure at Fermilab and partnering with NSF
  - Develops infrastructure that positions the U.S. to regain Energy Frontier (Muon Collider)

- **Promising opportunities for advancing particle physics identified at Cosmic Frontier**
  - Requires partnering with NASA, NSF, etc.

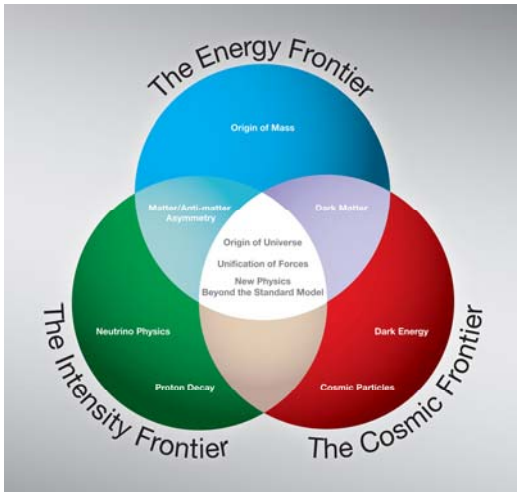
- **HEP at its core is an accelerator based experimental science**
  - Accelerator R&D develops technologies needed by the field and that benefit the nation

KOVAR

HEPAP (P5) Report

My Comments

- **P5 seriously addressed the charge given by DOE/NSF:**
  - **to examine the scientific opportunities and options**
  - **for mounting a world class particle physics program**
  - **at different funding levels**



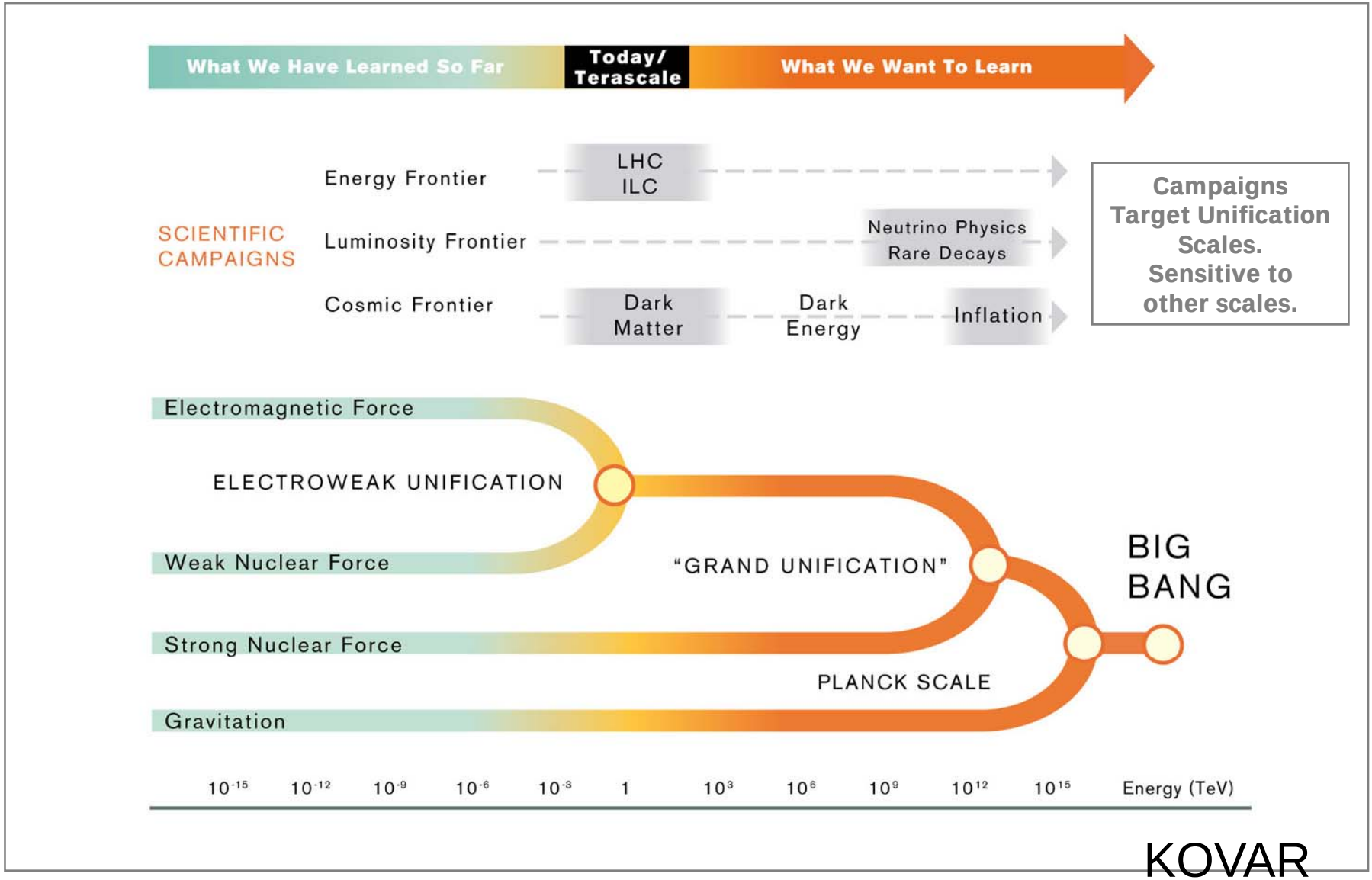
- **Grappled with the issue of how to mount a world-class program that addresses the highest priority scientific opportunities identified with the funding available**

- **Result is a realistic vision whose priorities are consistent with the major findings - that is robust and that should produce outcomes that justify the investment**

- **Lays out what the nation will get with different investments**
  - Scenario B (FY 2007 level w/COL) - productive, world-class research program at all three frontiers - minor player in next generation Tevascale facility
  - Scenario A (FY 2008 level w/COL) – not adequate to mount productive, world-class programs at all three frontiers - not part of next generation Tevascale facility – U.S. leadership is significantly diminished
  - Scenario C (FY 2007 ACI level) – Scenario B, but faster, cheaper and better!
  - Scenario D (additional above C) – the funding needed to host next generation Tevascale facility

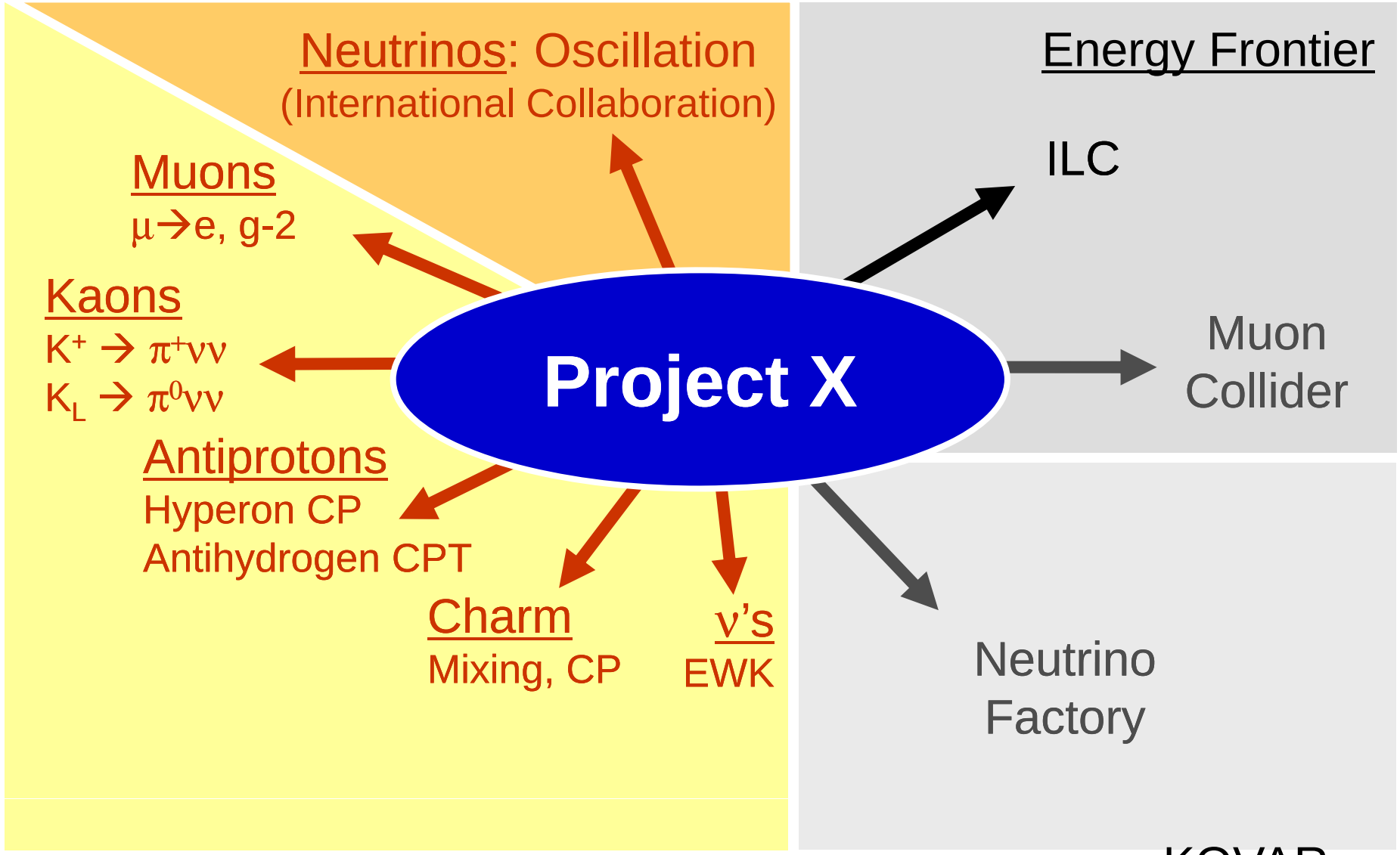
KOVAR

Information from all Scientific Campaigns needed to achieve the Ultimate Goal



KOVAR

Possible Opportunities with a proposed Fermilab "Project X"



P5 Executive Summary:
Enabling Technologies

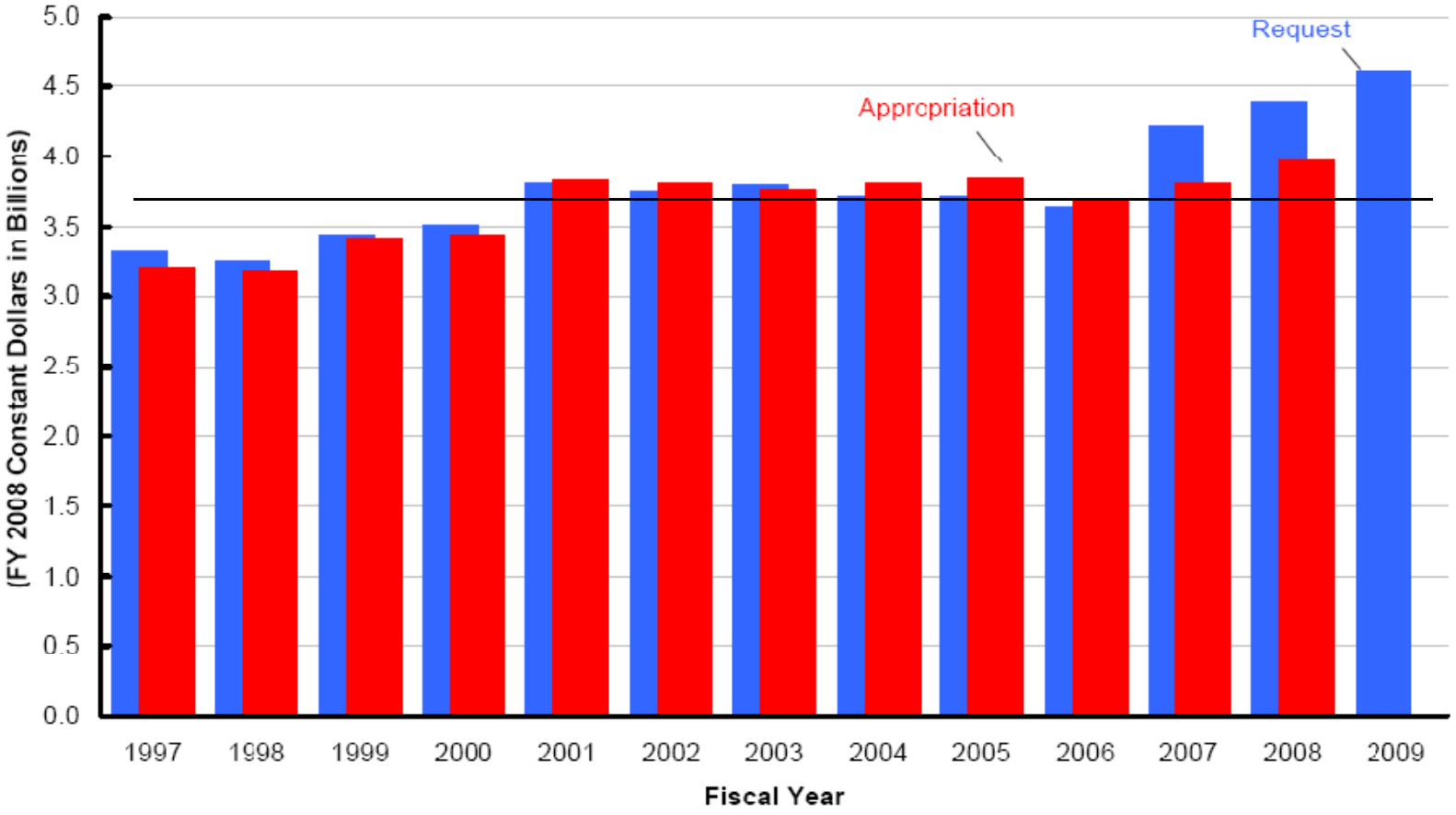
- **"The panel recommends a broad strategic program in accelerator R&D, including work on ILC technologies, superconducting rf, high-gradient normal-conducting accelerators, neutrino factories and muon colliders, plasma and laser acceleration, and other enabling technologies, along with support of basic accelerator science."**

- **"The panel recommends for the near future a broad accelerator and detector R&D program for lepton colliders that includes continued R&D on ILC at roughly the proposed FY 2009 level in support of the international effort. This will allow a significant role for the US in the ILC wherever it is built. The panel also recommends R&D for alternative accelerator technologies, to permit an informed choice when the lepton collider is established."**

KOVAR

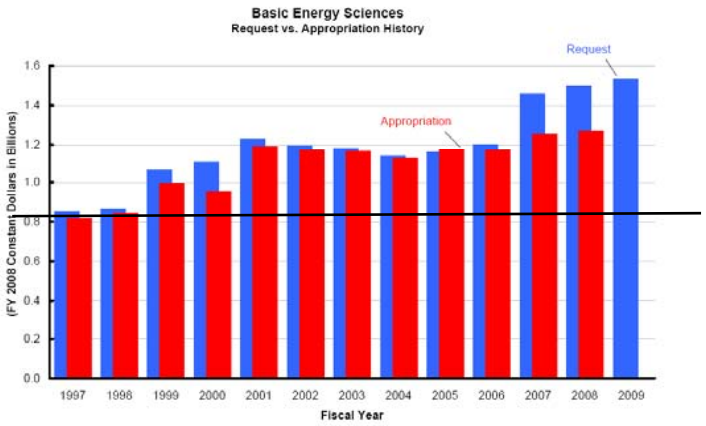
Budgets

SC Request vs. Appropriation History
(FY 2008$)

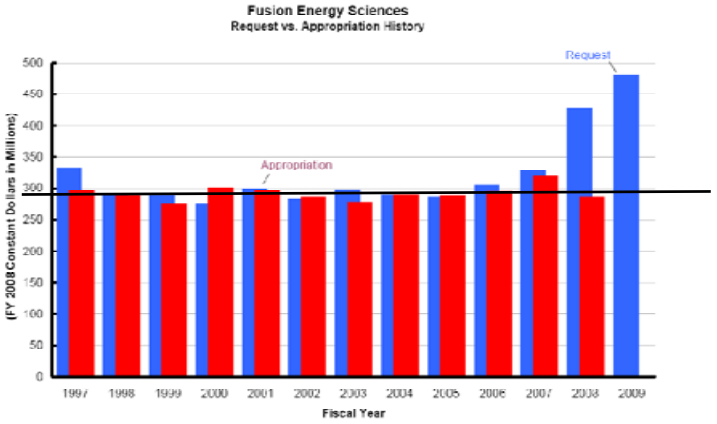


KOVAR

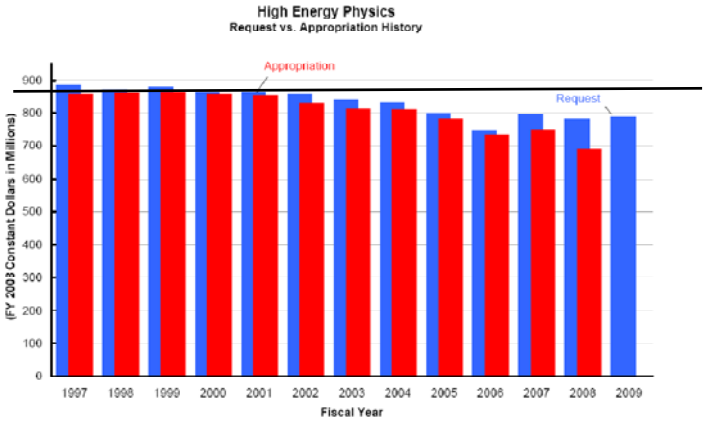
BES



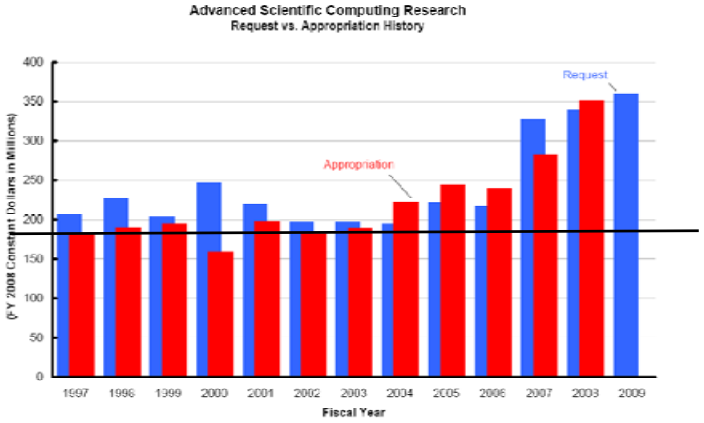
FES



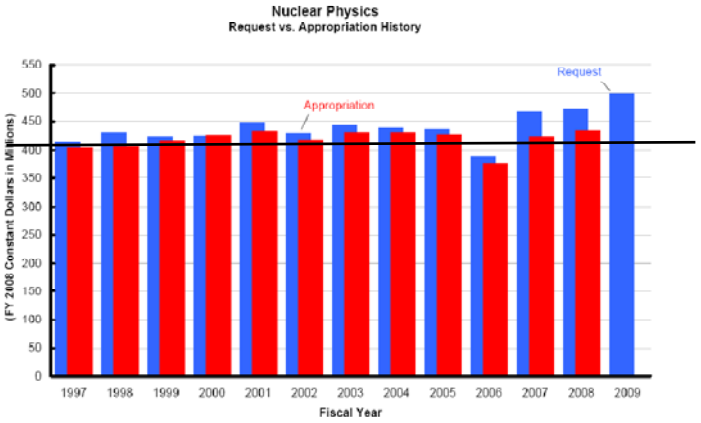
HEP



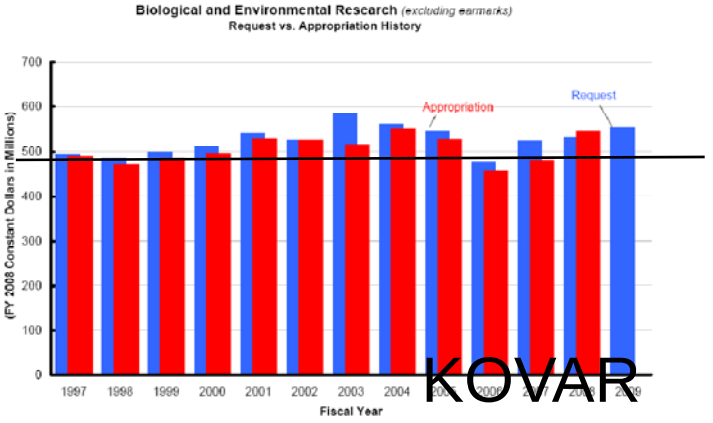
ASCR



NP



BER



KOVAR

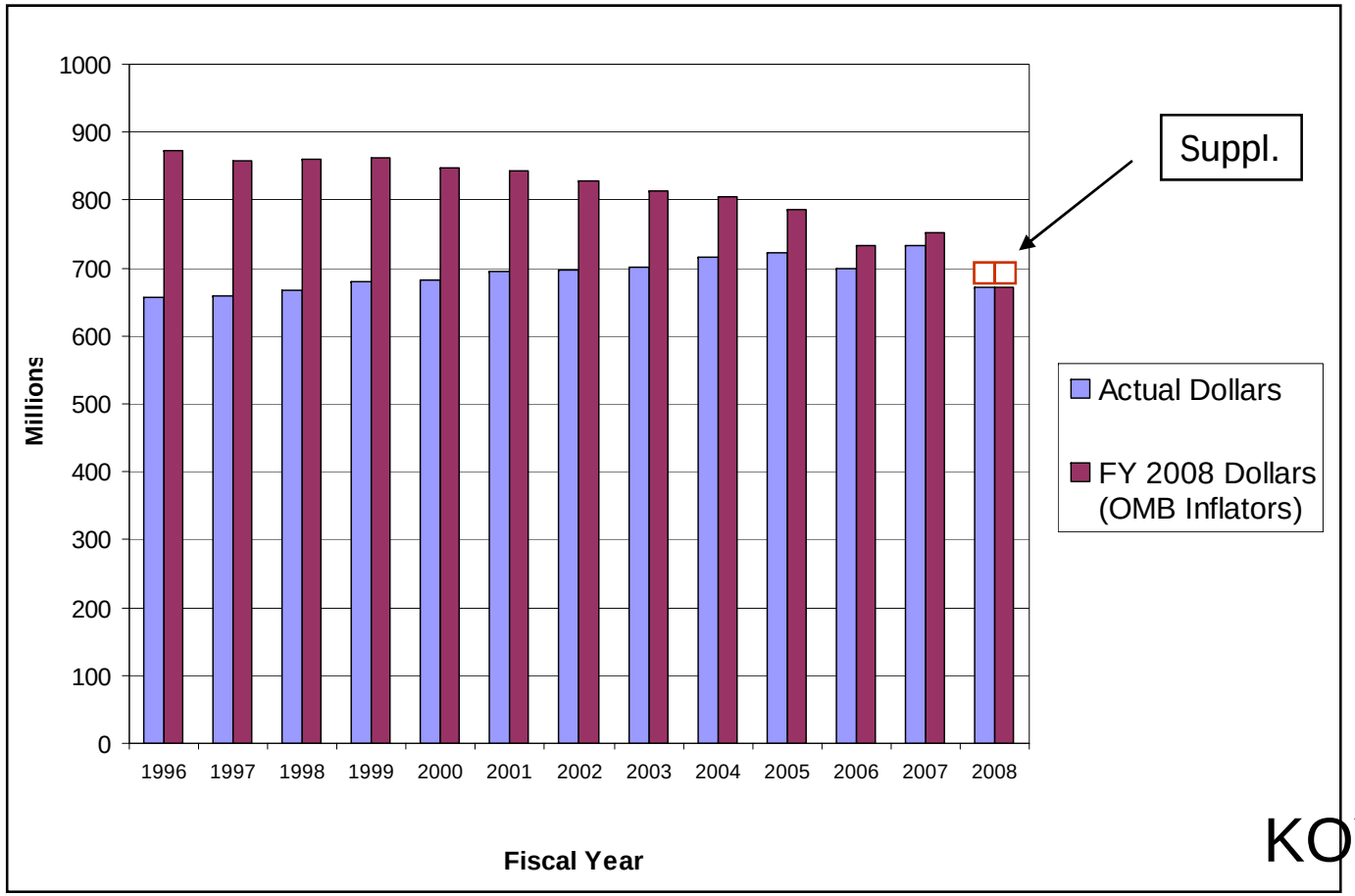
DOE HEP Budget Realities
Funding Trends Are Austere

office of high energy physics

Department of Energy
Office of Science

- U.S. HEP funding has been eroded by inflation : FY 2007/FY 1996 ~ - 16%
- U.S. HEP has closed Facilities: BNL/AGS (FY 1999): SLAC/B-Factory (FY 2008)
- HEP FY 2008 funding was a -8.5% reduction from FY 2007: FY 2008/FY1996 ~ -23%

(Partially mitigated by emergency supplement providing $32M to HEP)



KOVAR

FY 2008 Budget/Program

FY 2008 Appropriations ($689M → 8.4% reduction compared to FY 2007)

- **A Productive Program**
  - **Tevatron is running well – CDF/D0, MINOS, MiniBooNE**
  - **B-Factory completed successful four month run**
  - **LHC circulating beam and ATLAS/CMS ready**
  - **GLAST collecting data**
  - **Many projects are underway: Minerva, T2K, Daya Bay, EXO, DES, CDMS**
  - **DOE/NASA planning to proceed on JDEM**
  - **DOE/NSF discussing participation in LHC Phase I upgrade**
  - **DOE review for Advanced Plasma Acceleration Facility (APAF)**
  - **10 OJI awards in FY 2008 (increased $500k → $750K)**
  - **~22 awards (out of 69) Dark Energy R&D (~$3.8M)**
- **There have been significant impacts**
  - **Staff reductions at SLAC and Fermilab**
  - **Work on NOvA stopped**
  - **ILC & SRF R&D supported at a minimal level**

FY 2008 Supplemental

- **$32M for HEP ($29.5M for Fermilab, $2.5M for SLAC)**

KOVAR

FY 2009 President's Budget Request

- **The DOE SC Budget Request is $ 4,721 Million**
  - It is a **+21%** (+$819 Million) increase compared to **FY 2008 Appropriations**
  - It is a **+24%** (+$909 Million) increase compared to **FY 2007 Appropriations**

- **The DOE SC HEP Budget Request is $ 805 Million**
  - It is a **+11.6%** (+$83.1 Million) increase compared to **FY 2008 Appropriations (plus supplement)**
  - It is a **+ 7.1%** (+$53.1 Million) increase compared to comparable **FY 2007 Appropriations**

- **There are a number of significant program shift**
  - **B-Factory run completed**
    begin ramp-down and D&D. Data analysis will continue for a few years
  - **Tevatron running full-out**
    either discovery or significant limits on New Physics in advance of LHC
  - **NOvA project proceeds**
    one year delay in schedule and increase in cost
  - **U.S. researchers playing leading roles at LHC**
    increased funding to support efforts
  - **Joint Dark Energy Mission (JDEM) R&D ramping up**
    to complete conceptual design and select a mission concept in FY 2009
  - Accelerator R&D efforts modified in light of ILC developments
    to address near-term, mid-term and long-term opportunities

KOVAR

office of high energy physics

FY 2009 Budget Request
ILC and Accelerator R&D

Department of Energy
Office of Science

A central challenge for the U.S. and international HEP community has been

- **to define and execute a balanced scientific program**
- **that includes a next generation collider at the energy frontier.**

The International Linear Collider (ILC) is widely viewed as that collider, but:

- The ILC physics case and some design parameters depend on results from the LHC
- It is a complex, challenging, multi-billion $ investment that requires international commitments
- This will take some time

FY 2009 Budget Request:

- Continues support for a U.S. role in the global ILC R&D effort, but focused on areas where the U.S. is the acknowledged leader
- Maintains a balanced scientific program that will preserve options for U.S. leadership in targeted areas, both in the LHC era and whatever comes next
- Supports overall strategy for accelerator technology R&D has both short-, medium- and long-term components to provide options for the U.S. program over the next decade

KOVAR

FY 2009 & FY 2010

FY 2009 Budget Request ($805M → +$115M over FY 2008 ($689M))

- However, expectation of six month Continuing Resolution (CR)
  - Tevatron plans to run six months into FY 2009
  - LHC program will be supported (but no growth)
  - Some projects will be delayed
  - Still plan to proceed with JDEM selection
  - Continue discussions on participation in LHC Phase I upgrade
  - APAF project will be delayed
  - Across program – the higher priority programs are supported
- If year-long CR the impacts will be significant
  - RIFs of 175-200 at labs and ~80 (PhDs/students) at universities
  - Tevatron Operations will be terminated at end of six months
  - NOvA project cancelled and other projects delayed or canceled
- Appropriation is pivotal
  - Future of HEP Program will depend upon level of FY 2009 Appropriation
  - HEPAP (P5) Report viewed as important for determining funding level

FY 2010 Budget Request to be submitted by new administration

- DOE is developing plans for programs at different funding levels
- HEP are using HEPAP (P5) findings/recommendations in it plans

KOVAR

Summary

HEP is in an exciting period

- **Near term future has incredible potential**

A pivot point in the U.S. for the HEP program (and physical sciences basic research)

- **There is support for research and development – but there is a debate about how much should go for short-term, mid-term and long-term (basic) research**
- **The Administration has strongly supported long-term basic research**
  - **FY 2009 Budget Request provides funding for doubling funding for SC**
- **However, expect a Continuing Resolution (funding at previous level) for 6 months**
- **President will not submit a FY 2010 Budget Request**

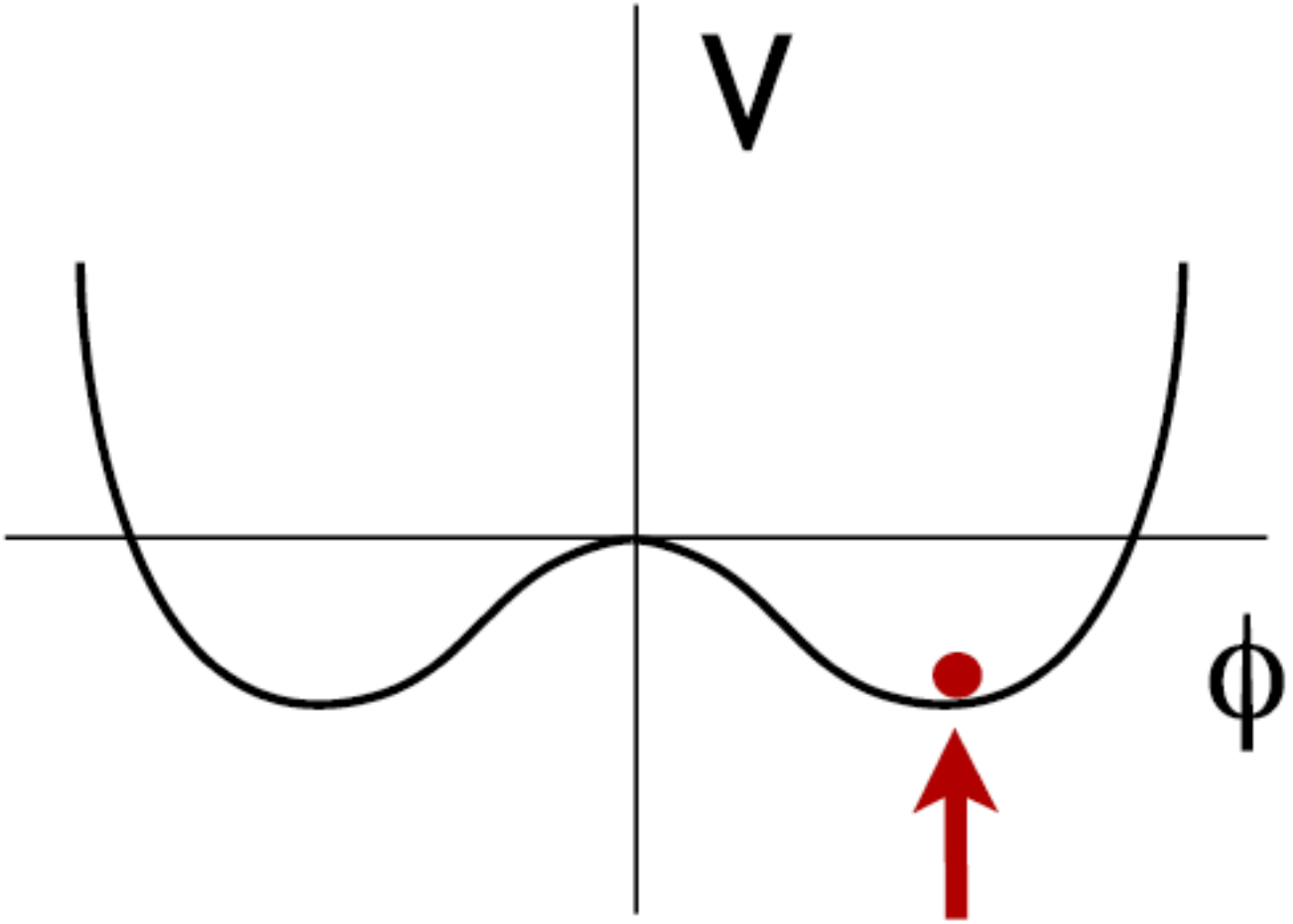
HEPAP (P5) has presented a vision for the U.S. program

- **It appears to be realistic and robust**
- **It has been (is being) used in the development of the DOE OHEP strategic plan and budgets**

OHEP will use this vision as basis for requesting funding

- **To try to change the direction of the U.S. HEP program that was implied in the FY 2008 Omnibus Bill (and has been the trend over the last decade)**
- **To ensure a strong, productive world-class program with resources available**

Michael Peskin



The supercollider era has begun.

We expect, in the next 1-3 years, to discover the next spectroscopy.

This discovery will redefine the central questions in collider physics, flavor physics, and dark matter.

This discovery dictates a program that includes ILC, flavor factories, and astrophysical dark matter detection.

A revolution is coming. We need to be ready.

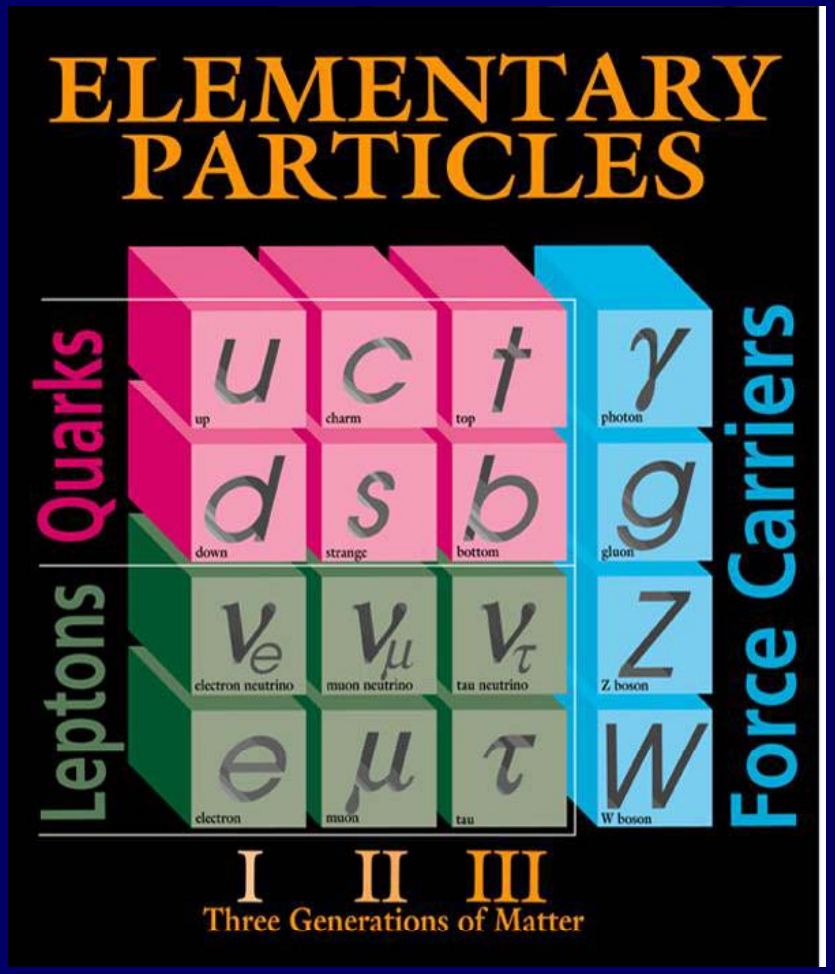
PESKIN

Summary

* SLAC is engaged in LHC, Super B, and Project-X R&D
  - Solid programs with significant effort
* P5 noted that a future lepton collider will be a necessary complement to the LHC
  - A linear collider can provide this capability
* Many options for the next-generation collider with different levels of development, risk and costs
  - ILC: most developed, lowest risk but high cost
  - X-band klystron: medium risk but significant cost savings
  - X-band Two-beam: higher risk but probably greater savings
  - Dielectric or Plasma acceleration: much higher risk but potential for much lower costs
* SLAC infrastructure can support critical HEP accelerator R&D

What should ILC detector be able to do ?

Identify ALL of the constituents that we know & can be produced in ILC collisions & precisely measure them.
(reconstruct the complete final state)



u,d,s jets; no ID
c, b jets with ID
t final states; jets + W's
ν's: missing energy; no ID
e, μ: yes
τ through decays
γ ID & measure
gluon jets, no ID
W,Z leptonic & hadronic

Use this to measure/identify the NEW physics

WEERTS

Main Detector Design Criteria

Requirement for ILC

- Impact parameter resolution

$$\sigma_{r\phi} \approx \sigma_{rz} \approx 5 \oplus 10/(p \sin^{3/2} \vartheta)$$

- Momentum resolution

$$\sigma\left(\frac{1}{p_T}\right) \approx 5 \times 10^{-5}\ (GeV^{-1})$$

- Jet energy resolution goal

$$\frac{\sigma_E}{E} = \frac{30\%}{\sqrt{E}} \qquad \frac{\sigma_E}{E} = 3-4\%$$

- Detector implications:
  - Calorimeter granularity
  - Pixel size
  - Material budget, central
  - Material budget, forward

Compared to best performance to date

- Need factor 3 better than SLD

$$\sigma_{r\phi} = 7.7 \oplus 33/(p \sin^{3/2} \vartheta)$$

- Need factor 10 (3) better than LEP (CMS)

$$\sigma\left(\frac{1}{p_T}\right) \approx 6 \times 10^{-4}\ (GeV^{-1})$$

- Need factor 2 better than ZEUS

$$\frac{\sigma_E}{E} = \frac{60\%}{\sqrt{E}}$$

- Detector implications:
  - Need factor ~200 better than LHC
  - Need factor ~20 smaller than LHC
  - Need factor ~10 less than LHC
  - Need factor ~ >100 less than LHC

Observation: Need substantial improvement in precision WEERTS

Performance requirements/Physics requirements

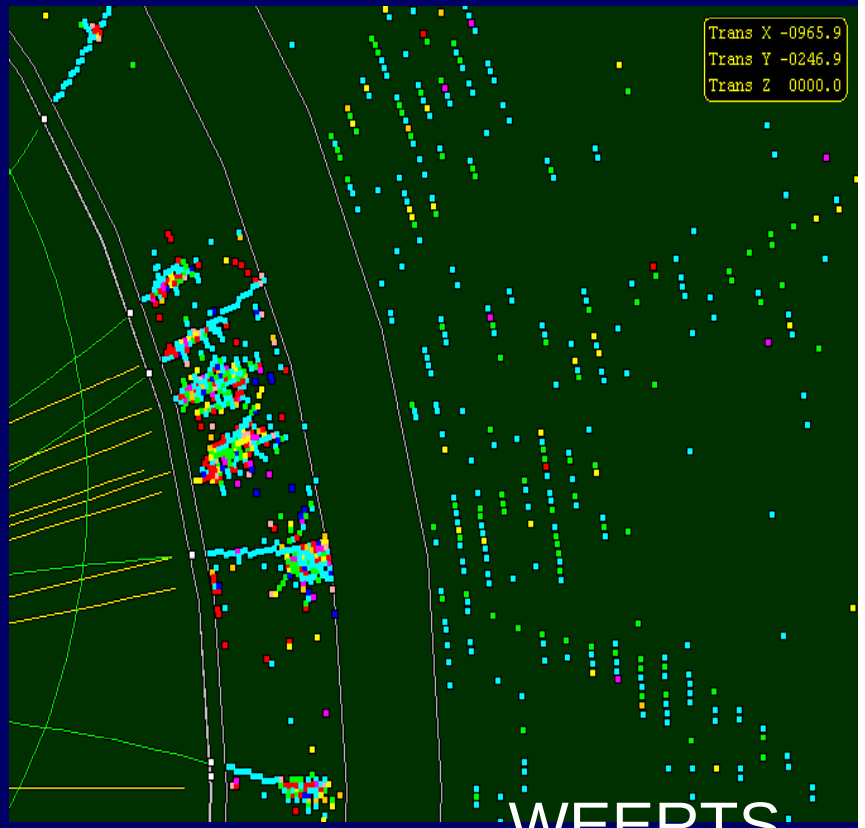
LC Physics calls for Jet Energy Resolution $\Delta E/E$ = 3-4%
(factor of 2X better than today's state of the art to resolve W's/Z's)

Particle Flow Algorithms (PFAs) promise the needed gain in jet energy resolution

PFA Calorimetry

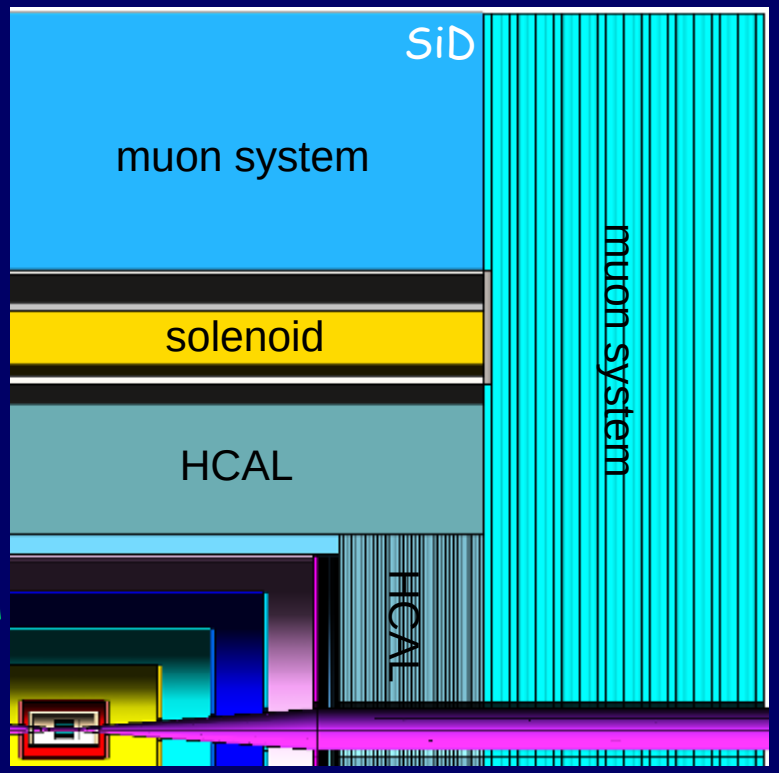
- Measure charged energy in tracker
- Measure photon energy using electromagnetic calorimeter
- Measure neutral hadron energy in hadronic calorimeter
- Avoid confusion from charged tracks

Measure the energy of every particle, not the energy deposited in calorimeter



SiD Design Concept (starting point)

- "Jet Energy measurement =PFA" is the starting point in the SiD design
- Premises at the basis of concept:
  - Particle flow calorimetry will deliver the best possible performance
  - Si/W is the best approach for the ECAL and digital calorimetry for HCAL
  - Limit calorimeter radius to constrain the costs
  - Boost B-field (5T)to maintain BR^2
  - Use Si tracking system for best momentum resolution and lowest mass (5 layers)
  - Use pixel Vertex detector for best pattern recognition (5 layers)
  - Keep track of costs
- Detector is a single fully integrated system, not just a collection of different subdetectors



Robust in ILC operations (beam losses)

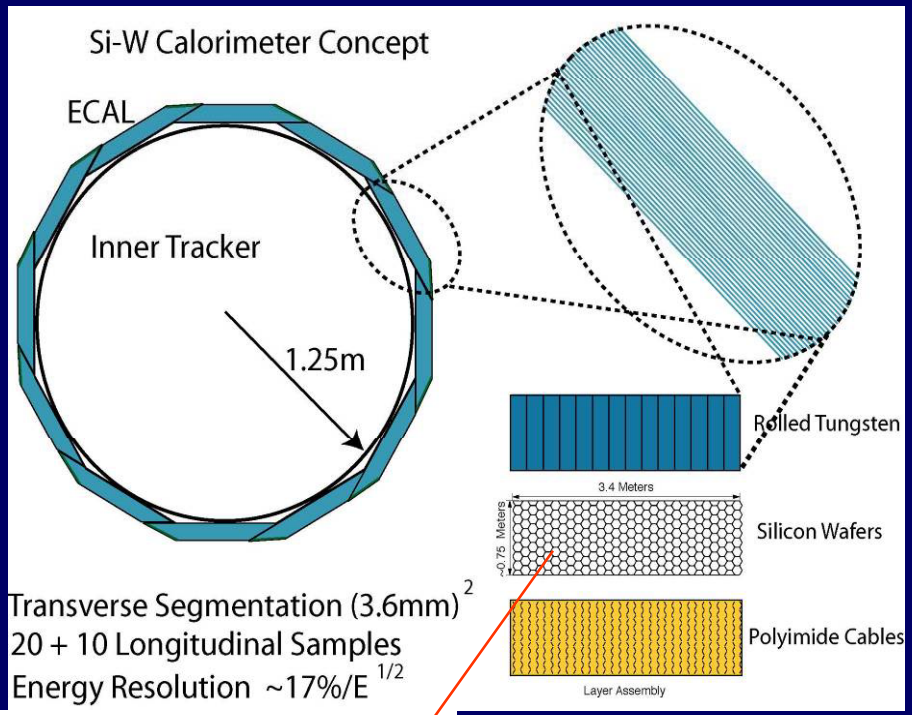
Compact: 12m x 12m x 12 m

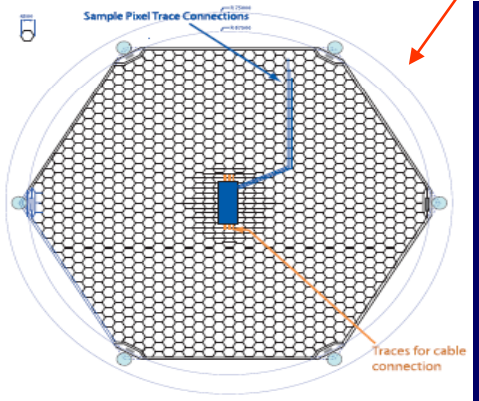
WEERTS

Calorimetry: ECAL & HCAL

PFAs call for new types of calorimeters and readout…

Si/W ECAL



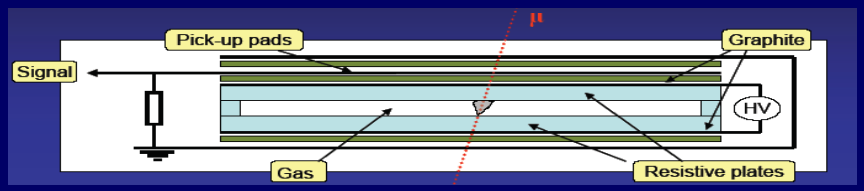


Sensor + KPiX

13 mm^2 pixels
Readout 1k pixels
per Si sensor (KPiX)

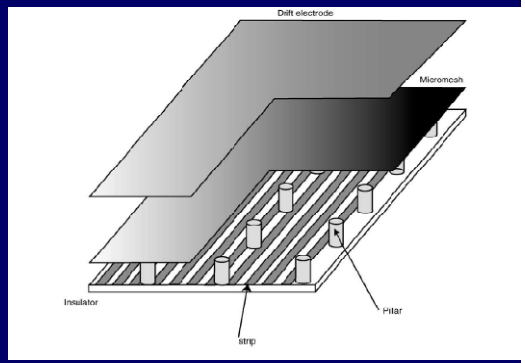
Highly Segmented HCAL

RPC



GEM

µMega

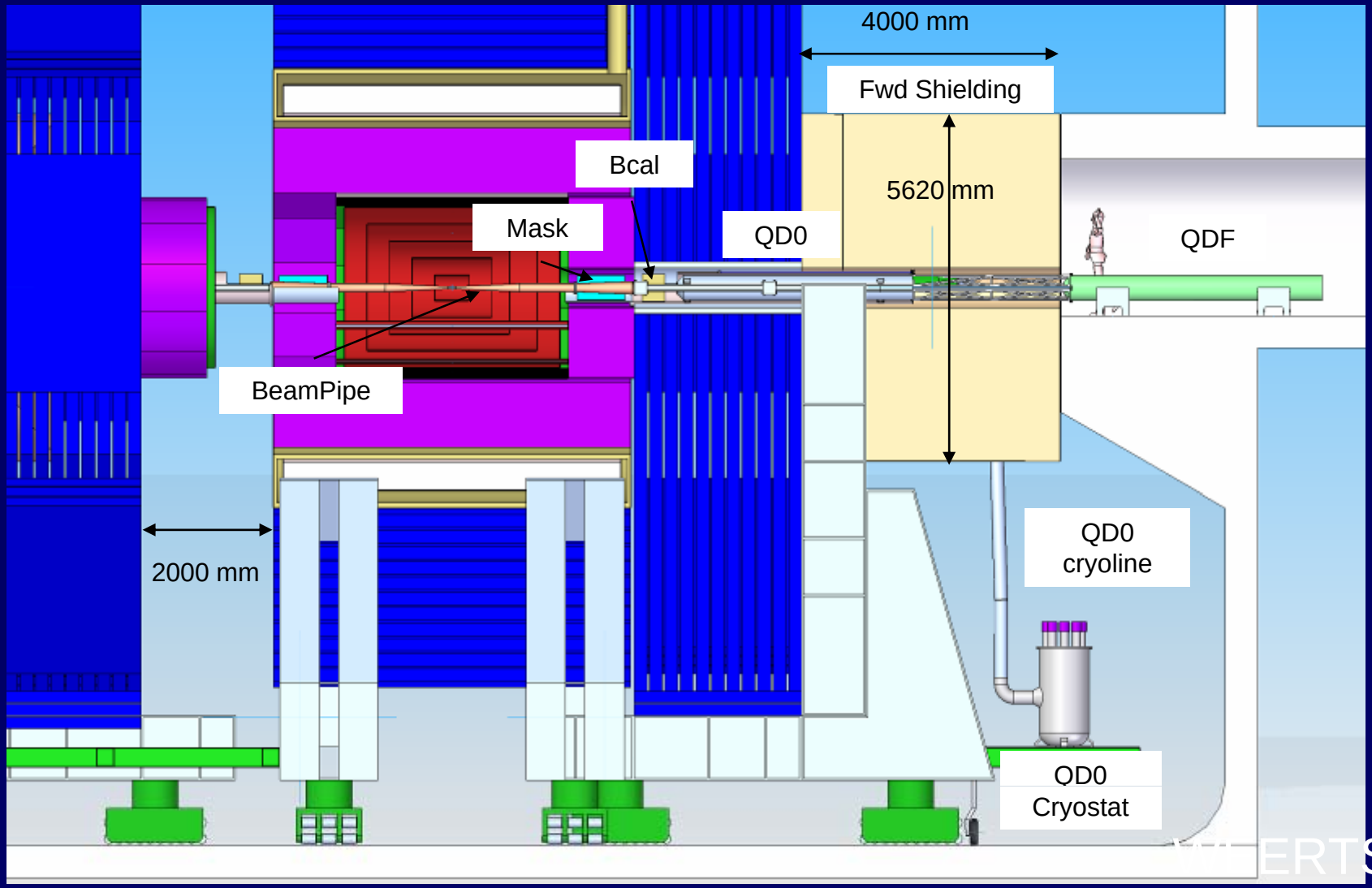


Example of R&D

WEERTS

Machine-Detector Interface

The first step is to translate the parameters in an engineering model, formulating technical solutions, clearances and components integration



Why do this now ? and not later

Close coupling between machine ⟷ detector (=one piece)

Accelerator ⟷ Experiment

"Critical for machine design" *B.Barish*

Physics simulation = physics performance of "complex" can only be done with a machine & detector concept

Detector concepts develop frameworks to do this

Physics requirements drive detector concepts, which guide/define R&D

R&D to meet detector performance takes long time

Detector concept & development integral part of any LC.

WEERTS

Panel Discussion

- Barry Barish
- Jonathan Dorfan (Moderator)
- Gil Gilchriese
- Patric Muggli
- Michael Peskin
- Blair Ratcliff
- Tor Raubenheimer
- Harry Weerts